Space Weather Technical Forecast

Issued on Friday, 24 February 2023 at 01:20 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-class flares (R1-R2/Minor-Moderate radio blackouts) likely throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with two low M-class flares occurring over the last 24 hours. There are now five numbered sunspot regions on the visible disc, all with complex or very complex magnetic configurations, but varying in size. The largest region on the visible disc, and one of two regions with a beta-gamma-delta configuration, is AR3234. Most regions displayed slight growth, including a new small, weak and simple region in the southeast quadrant which is yet to be number.

Currently no significant Earth-directed CMEs are forecast, although glancing impacts may occur on Saturday.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by DSCOVR at L1, were indicative of a High Speed Stream (HSS) from CH77/+. The solar wind was predominantly elevated between 540-560 km/s, although briefly reached Strong levels during the evening, peaking at 606 km/s at 23/2238 UTC. The density, was often above average, especially early and late in the day, but fluctuated and occasionally fell to below average levels. The IMF has been predominantly at Moderate levels, generally between 8-10 nT, but then falling to weak levels late in the day. The north-south component, Bz, was generally weakly negative, although was briefly moderately negative, reaching -10 nT at 23/0047 UTC. The phi angle was mainly away from the Sun (positive), with some occasional negative (toward the Sun) periods early and late in the day. Geomagnetic activity was Unsettled to Active (Kp 3-4).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES16 remained at Background levels. High energy electron flux (greater than 2MeV) at GOES16 was initially at background levels, but steadily increased to moderate levels later in the day, and very briefly reached High levels of 1008 pfu at 23/1930 UTC. The associated 24-hour electron fluence has been well below the Active (1e8 integrated pfu) threshold, reaching 1.08e7 integrated pfu at 24/0001UTC, but showed a sharply increasing trend late in the day.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate solar activity is likely to continue, with a slight chance of High activity. The most likely regions to flare are AR3234 and AR3235 as both have delta spots. However, new or returning regions are likely to rotate onto the visible disc during the four day outlook period, potentially adding to the chance of significant flares.

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Solar Wind / Geomagnetic Activity: There are is a low confidence CME in the forecast, perhaps arriving on the 25th. Earth is currently experiencing a HSS from CH77/+, but this is likely to have only minor impacts. However, two further coronal holes, CH78/- in the southern hemisphere and CH79/- approaching centre disc, are likely to influence Earth at times from tomorrow onwards. Therefore the solar wind is expected to be slightly elevated to elevated throughout, with a chance of reaching strong levels later day 4 due to a HSS from CH79. Geomagnetic activity is expected to be Quiet to Active (Kp 2-4) with an increasing chance of G1/Minor Storms due to a combination of different HSS.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is most likely to remain at Background levels, but with a Slight Chance of reaching the S1 level. High energy (greater than 2 MeV) electron flux is expected to be at Moderate to High levels with the High threshold being breached at the peaks of the diurnal cycles. The associated 24-hour fluence is expected to remain below the Active threshold (1e8 integrated pfu) today and tomorrow but with a rising trend, and an increasing chance of exceeding the Active threshold.

Figure 1. Solar Analysis Valid 23/2000 UTC.

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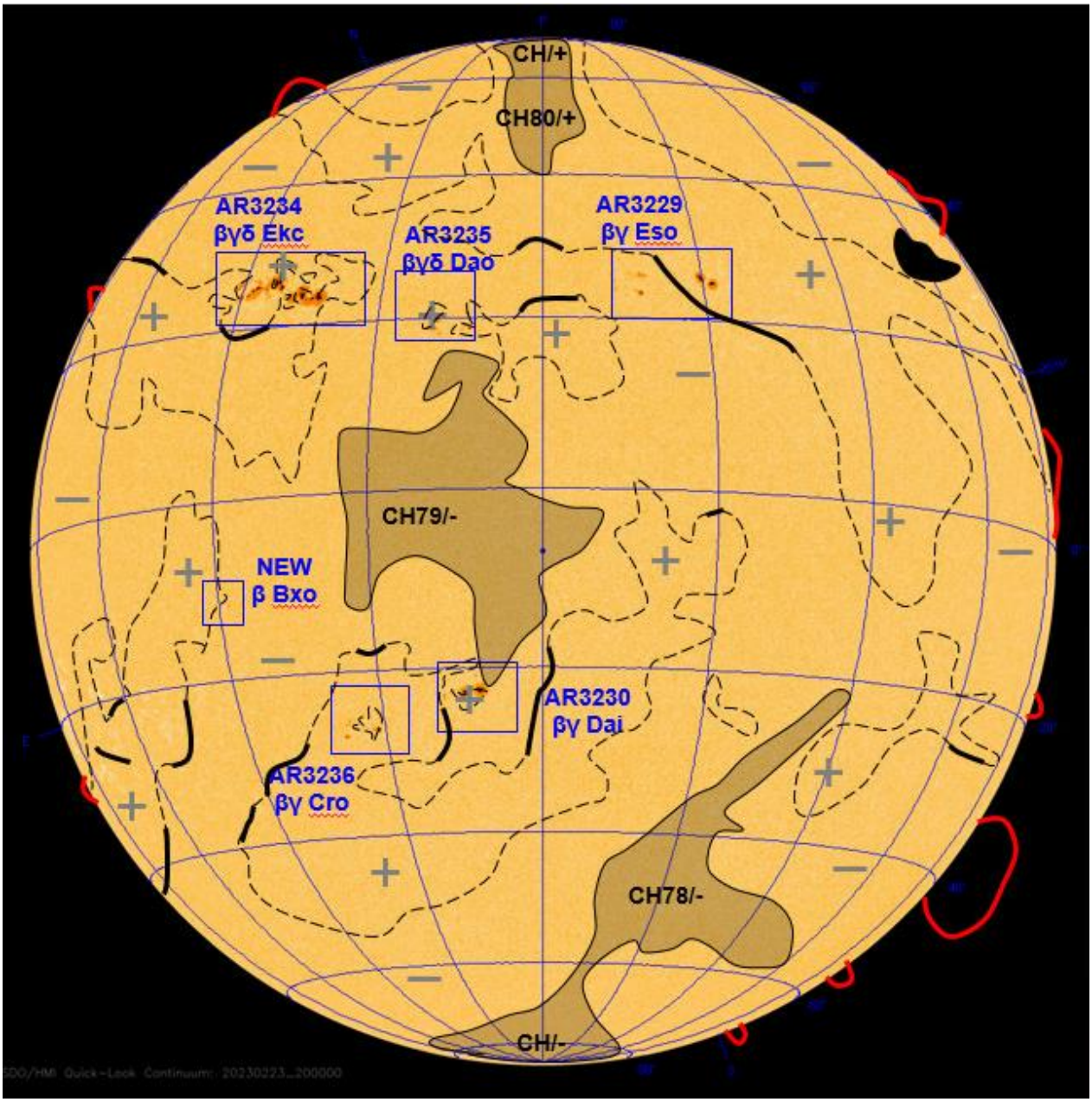
Met Office Space Weather Technical Forecast



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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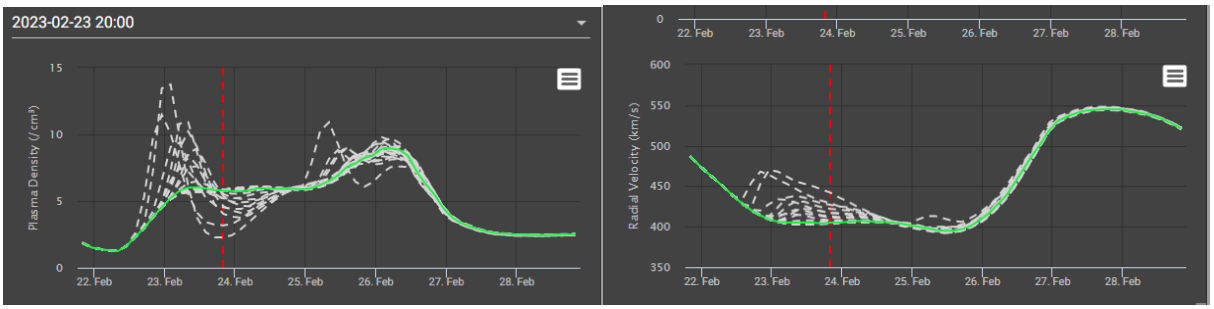
Geomagnetic Storms:

A glancing blow from a CME is possible on 25 Feb, from a CME that left the Sun from the northwest on 21 Feb, but most of this should pass above Earth and confidence is low. Earth is experiencing a HSS from CH77/+, but this is likely to have only minor impacts and should gradually wane through 23 Feb. However, two further coronal holes, CH78/- in the southern hemisphere and CH79/- approaching centre disc, are likely to influence Earth at times from tomorrow onwards. Therefore the solar wind is expected to be slightly elevated to elevated throughout, with a chance of reaching strong levels later day 4 due to a HSS from CH79. CH78 is a non-persistent feature so no information is available from the previous rotation, and the timing is therefore low confidence with the arrival possible between late today until 26 Feb. CH79 was present on the previous rotation, but has developed into a larger feature on this rotation, and so is likely to produce a stronger enhancement than persistence would otherwise indicate. Both coronal holes have negative polarity, and therefore are more likely to be favoured for a geomagnetic response now we are approaching the March equinox.

Geomagnetic activity is expected to be Quiet to Active (Kp 2-4) with an increasing chance of G1/Minor Storms due to a combination of different HSS.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	10	20	30
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: MOSWOC Enlil ensemble forecast showing low confidence for a potential CME arrival on the 25th and HSS enhancements later in the forecast period.



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Radio Blackouts - X-Ray Flares:

There are six sunspot regions are on the visible disc. AR3229 in the northwest remains stable, with a beta-gamma configuration. AR3230 in the southeast is the second largest region, and has simplified recently to become a beta-gamma classification with the previous delta spot fading. AR3234 remains the largest spot and most significant region, with a gamma configuration, a large delta region in the compact centre portion, and has recently increased slightly in area. Newly numbered region AR3235 remains small in area, but has become complex with a small delta spot developing. AR3236 has also been recently numbered, and since emerging has increased slightly in spot number and magnetic complexity. Another new region has emerged in the southeast quadrant, but is currently small, magnetically simple and weak.

Solar activity is Moderate with two low M-class flares in the last 24 hours, and further M-class flares are likely. There remains a slight chance of High solar activity from any isolated X-class flares, primarily from AR3234, but also perhaps AR3235.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	70	60	60
Very Active	R3 to R5 X Class	No	15	15	10	10

Solar Radiation Storms - (High Energy Protons):

High energy (greater than 10MeV) proton flux, as observed by GOES16, is currently at Background levels. The probabilities remains steady through the period as regions rotate into more favourable positions for S1 events to occur.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	15	15	15	15
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) observed at GOES16 is now at mostly moderate

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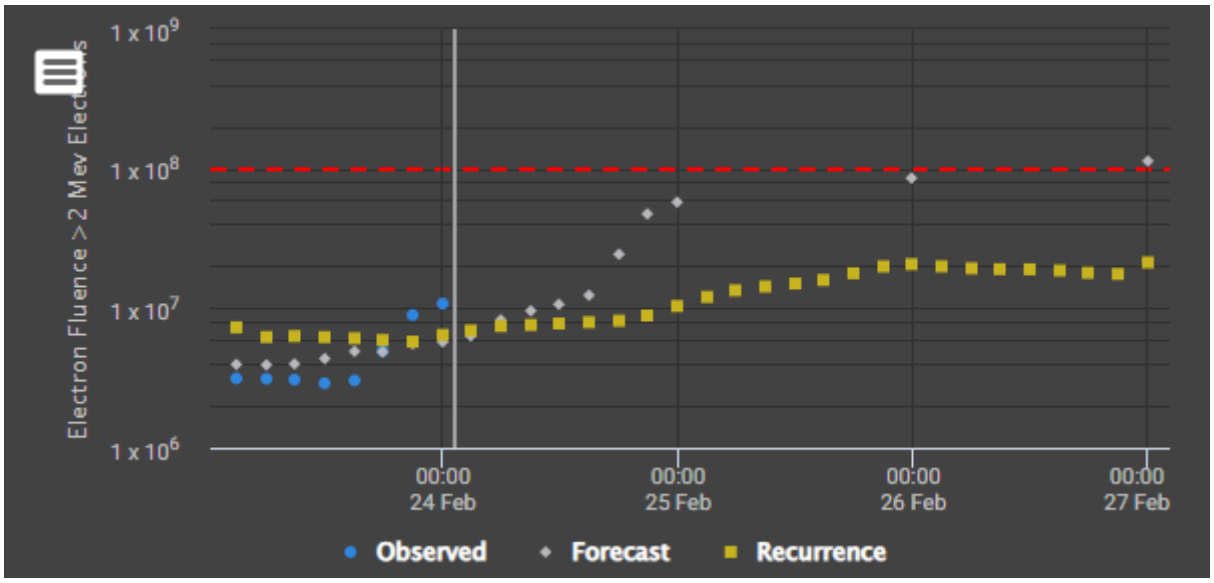
levels due to the influence of CH77. It is possible that a HSS from CH78 may arrive on 25 Feb, with the timing low confidence as this is a non-persistent feature, so recurrence is not a helpful forecasting guide here. A further and more significant HSS from CH79 is likely to arrive from day 3 onwards. Therefore there is an increasing chance of High flux levels being reached, despite occasionally enhanced geomagnetic activity.

The associated 24-hour fluence is expected to remain below the Active threshold (1e8 integrated pfu) today and tomorrow but with a rising trend, with an increasing chance of exceeding the Active threshold especially later in the period. MOSWOC REFM therefore appears to be offering good guidance, despite CH78 being a non-persistent feature and so REFM won't be taking account of this until the HSS arrives.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	5	20	30	40
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 3: Met Office REFM model



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